CSIR-National Metallurgical Laboratory
Jamshedpur, India

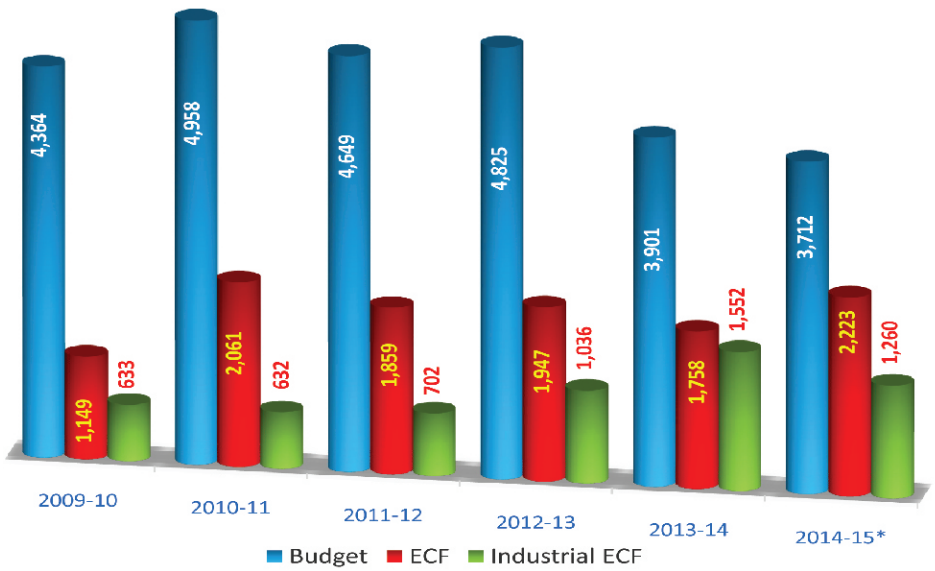
From the Director's Desk

Chairman & Members of the Research Council, Invitees and Dear Colleagues,

It is indeed a great pleasure to welcome all of you to this 67th Research Council Meeting of CSIR-NML and to briefly present to you our salient achievements and performance since the last Research Council meeting. I have tried to remain focused on my vision of CSIR-NML as a self sustained technology centre in the areas of minerals, metals and materials and tried to work consistently to achieve the Goals and Targets that we had set for 2016, namely:

- Achieve 50 % of NML's total budget from industrial sponsorship
- Achieve 80% direct utilization of man-power and major equipments
- Develop and commercialize five technologies that will have a lasting impact
- Realize 5% of operational budget from IP licensing and royalties
- Move towards a paperless NML
- Deliver on one national mission project
- Produce 20 PhDs/year from CSIR-NML through AcSIR
- 150 SCI publications/yr with an average citation of 10/paper

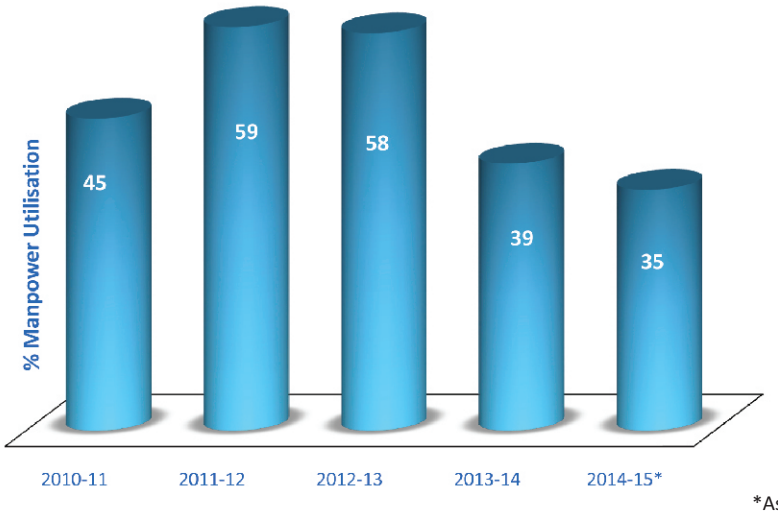
Our external cash flow through projects over the past five years as well as in this financial year (up to Jan 2015) is shown below :



*As on January,2015

Two trends are clearly visible; the first is that our industrial funding has consistently increased and in 2014-15 it is about 34% of the CSIR budget. The second trend is that our CSIR budget has consistently decreased over the past three years. With a bit more of effort both on enhanced industrial funding and a reduction in expenditure, it should be possible for us to achieve the target of industrial funding touching 50% of the CSIR budget.

However, our manpower utilization in R&D projects (ie., the time officially booked to projects) is still just around 35-40%, which is shown in the plot below is a cause of serious concern :



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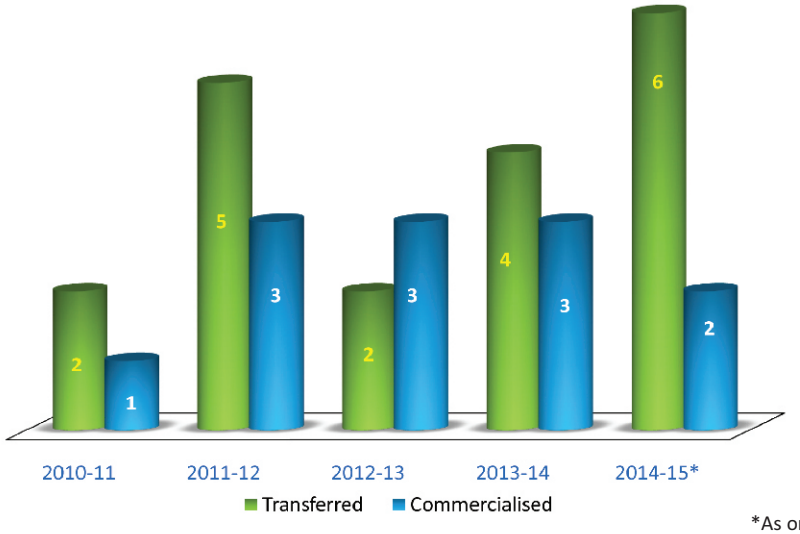
One of the reasons for the apparent decline in manpower utilization is the fact that until 2012-13, a significant extent of the manpower booking was to Grant-in-Aid projects, which actually does not support permanent manpower costs, whereas since 2013-14, a major part of the manpower booking is to sponsored and collaborative projects. However, that in the past two years, the manpower utilization in projects has not exceeded 40% surprised me because I could visibly see most of my colleagues being fully occupied and I would receive complaints from them that they are too occupied and they have no time for new projects. This made me seriously introspect as to whether there are systemic issues impeding higher man day utilization. For this purpose, I carried out a detailed analysis on the time available for R&D work at CSIR and noticed some startling facts. After accounting for all admissible leaves and the range of essential non-R&D activities that a scientist has to be associated with, the total time/scientist/year available for R&D activities works out to a minimum of 142 days for men and 102.5 days for women. In the plot shown above for the purposes of calculation of man days utilization, we have taken the average time available per scientist per year to be 220 days. If this data is normalized against the actual time available for R&D activities (ie., 142 days for men and 102.5 days for women), then the man day utilization factor works out to 64% which is more respectable. It is also realistic and necessary to reset our target of 80% man day utilization against the actual time available for R&D activities.

Technology development and transfer continues to remain our main emphasis. In the past six months, we have transferred four of our technologies to various entrepreneurs namely a) Annealing Simulator (M/S Krisjan Ltd.), b) Anti-tarnishing Lacquer (Multicoat Surfaces Private Limited, Kolkata) c) Melting direct reduced iron (DRI) using gas based furnace (Mayur Electro Ceramics Pvt. Ltd,Kolkata) and d) Production of ferrite and pigment grade mono-dispersed nano

iron oxide (Tata Pigment Ltd., Jamshedpur) of which the first two have been commercialized. I have no doubt that the other two technologies will also be commercialized in the next couple of years.

All modules of our Enterprise Resource Planning (ERP) system have been fully implemented and operational since April 2014 for all processes (except engineering) making us one of the first CSIR labs to go fully online.



*As on January, 2015

Our 12th five year plan projects have been progressing well and I am hopeful that these projects would lead to some significant technology developments. During the period from July to December 2014, four more pilot campaigns for Mg production were carried out, wherein various process parameters such as vacuum levels, alumina to silica ratio in slag, argon flow rate and cooling gases were varied. Although three of these campaigns were successful in terms of Mg production, in two of the campaigns, the deposits were fine, powdery and caught fire upon the opening of the condenser. Use of traces of acetylene along with Ar in the cooling cycle partially helped to address the pyrophoricity of deposits. The 9th campaign had to be stopped midway because of the choking of the charging chutes. I am sure that these campaigns have been a very valuable learning for all the team members. Several engineering issues still need to be resolved before we can go for the next scale of pilot plant ie., 1 ton/day. The 10th campaign is planned in the first week of February, 2015.

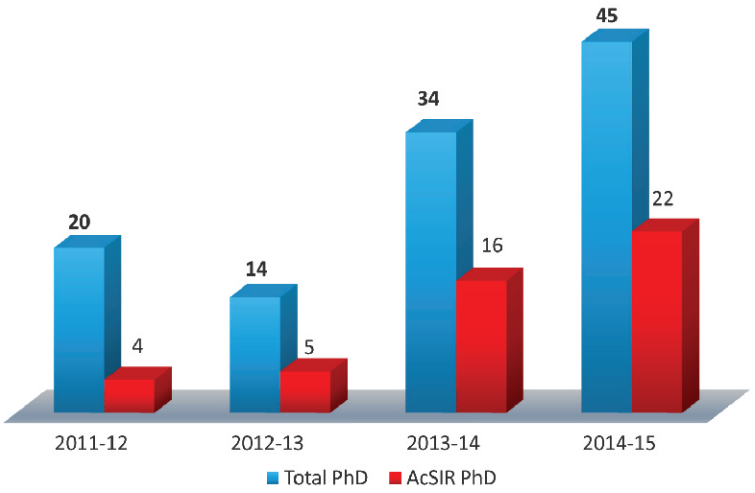
In the CRGO project pursued jointly by CSIR-NML, Tata Steel and RINL, Vizag, with the support of Min. of Steel, the purchase order for the preparation of the Detailed Project Report (DPR) towards the putting up of a 3-5 ton pilot plant has been placed with the Engineering Consultants. In parallel, activities on design of new inhibitor compositions, development of an indigenous processing schedule for this CRGO grade steel as well as MgO coating development has been initiated at the laboratory scale. It is known that hot rolling and subsequent annealing plays an important role in the development of a Goss texture {110}<001> in the final heat treated and secondary recrystallized product. Our proposed process is for thin slabs. Initially, MnS and AlN have been chosen to be the main inhibitors and a few such compositions have been induction melted and cast in the form of ingots. In addition, we are looking at the possibility of other inhibitor additions such as Nb, Ti, Mo, Sn etc. so as to hinder the grain growth by solute drag effect. Initial experiments have been successful in reducing the hot rolling temperature to below 1200^{0}C. The ingots are being further processed using different hot rolling schedules to achieve hot bands with desired

micro-structural gradient from the surface to the centre. Cold rolled sheets, deformed from 2 mm to 0.7 mm, show the evolution of Goss grains after secondary re-crystallisation.

In the 12th plan project on development of technology for dry beneficiation of coal being pursued jointly with CIMFR Dhanbad and IMMT Bhubaneswar, some significant results have been achieved. Three non-coking coal samples from Dakra, Gare Block and Rajmahal were taken for these studies. The dry beneficiation studies at coarser sizes (>6 mm) were carried out at CIMFR using an X-ray based Ore Sorter. The results show an ash reduction of 8-10% with a yield in excess of 65%. Fine coal (<1 mm) beneficiation using air table at 100 kg/h scale showed an ash reduction of 9% in single stage with a yield of 66% and a 3-stage operation yielded an ash reduction of 17% with a yield of <20%. These results are encouraging and I have no doubt that this technology if successfully developed at large scale can viably replace the wet washing circuit presently adopted at the different coal fields. Two other routes of dry beneficiation for coarse and intermediate sizes are also being explored using AKA-FLOW and FGX separators. These equipments are likely to be commissioned in about 6-8 months time. In the studies related to utilization of 'Coal Combustion Product', the geopolymer products developed at pilot plant has been tested for its durability. A patent on "An improved process to produce brick from sponge iron plant coal ash using geopolymerisation" has been filed along with Tata Sponge Iron Co Ltd. During this period, our industrial partner Tata Power Co Ltd has sponsored the study on "Development of marketable geopolymer cement from their fly ash'. Efforts are also on to transfer the technology to other MSME's through (a) CSIR Tech, Pune and (b) C-FARM, New Delhi.

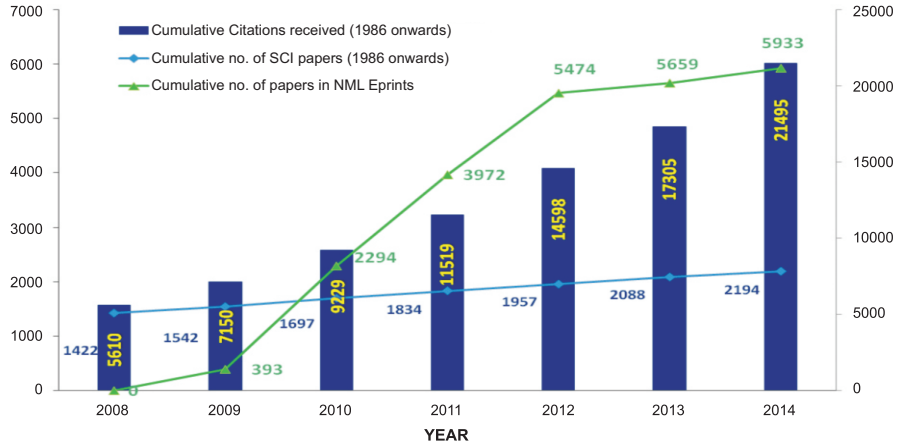
Another major and high value project (>Rs 12 Crores) taken up recently that I wish to highlight is the "Development of Technology for Hot Dip Galvanising for Advance High Strength Steels for Automotive Applications" through 50% of funding coming from the SDF grants of Ministry of Steel and the balance 50% from Tata Steel.

Our goal of producing 20 PhD students a year in Metallurgical and Materials Engineering, is on right track. The current status of the number of students registered for PhD in AcSIR is provided below :

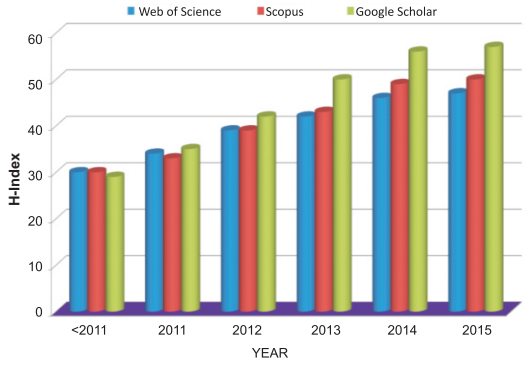


However, the major setback to the AcSIR efforts at CSIR-NML has been the non-resolution of the issues in the Trainee Scientist scheme by CSIR, which is causing uncertainty over the continuance of the scheme. The first batch of integrated M.Tech. PhD students have completed their M.Tech. Course and registered for PhD. The first PhD thesis from CSIR-NML has been submitted. Shri Ganesh Chaluvadi, SRF has submitted his PhD thesis in November 2014. Examiner reports have been received.

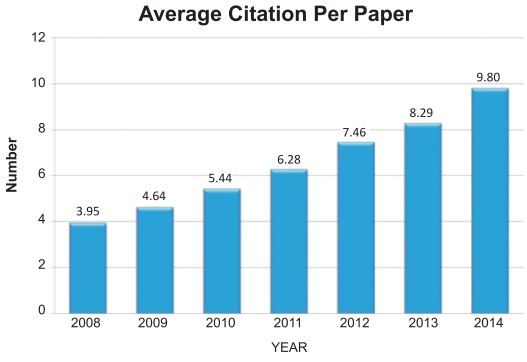
Although the number of SCI publications last calendar year (117) has not increased significantly, in terms of scientific impact, it has been impressive. I am of the opinion that we have done exceedingly well on this front over the past five years. The trend over the past five years in publications, number of citations received as well as the institutional H-index is depicted below :



Source : Web of Science / Scopus / Google Scholar as on 31.12.2014



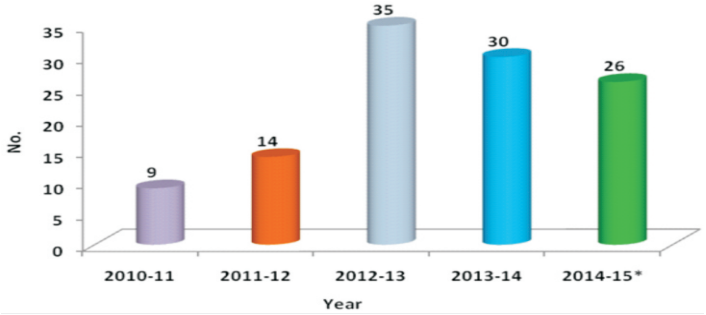
Source : Web of Science, Scopus, Google Scholar as on 31.01.2015



Source : Google Scholar as on 31.12.2014

An average citation/paper of close to 10 and an institutional H-index of close to 50 compares with among the best engineering laboratories worldwide. In addition to the quality of work which is inherent in these indices, much of the credit also goes to our NML e-prints team, who have remained focused on increasing the visibility and impact of NML's publications.

Our patent applications have remained more or less steady over the past three years as shown below :

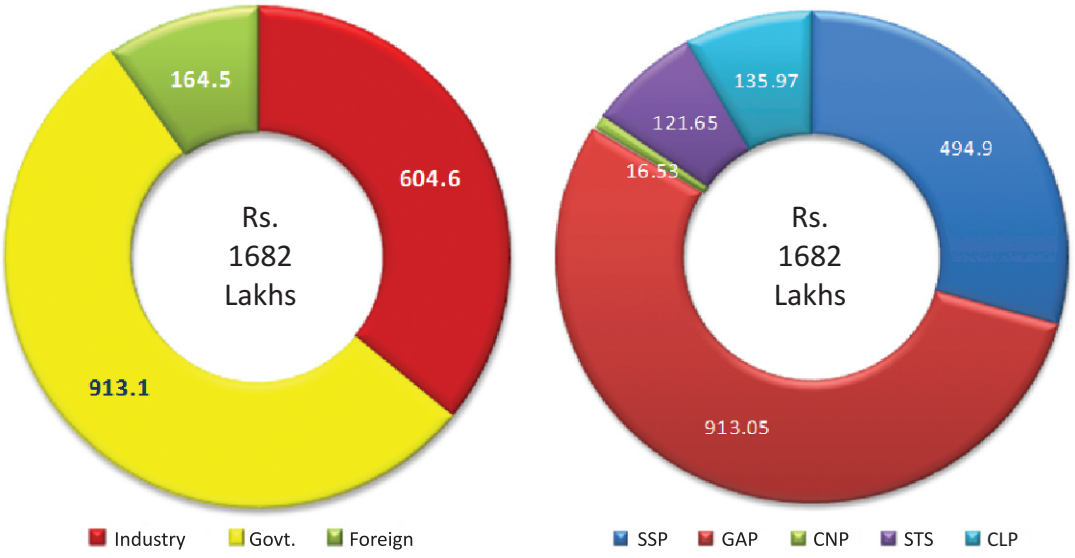


*As on January, 2015

However, the welcome feature is that many of these patents filed in the past three years are jointly with industries.

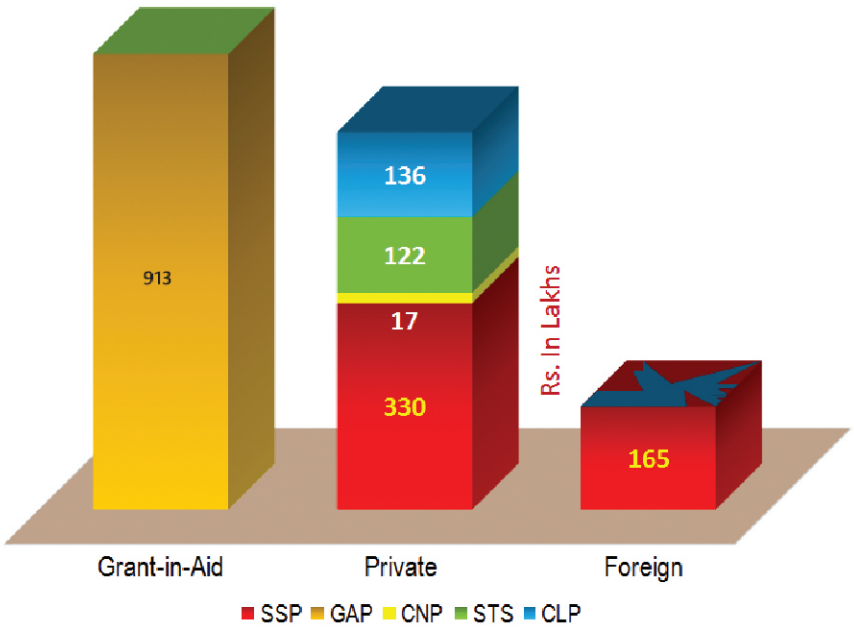
OVERALL PERFORMANCE IN THE PAST SIX MONTHS

The External Cash Flow of CSIR-NML during July to December, 2014 and its distribution among the various categories of projects is depicted below :



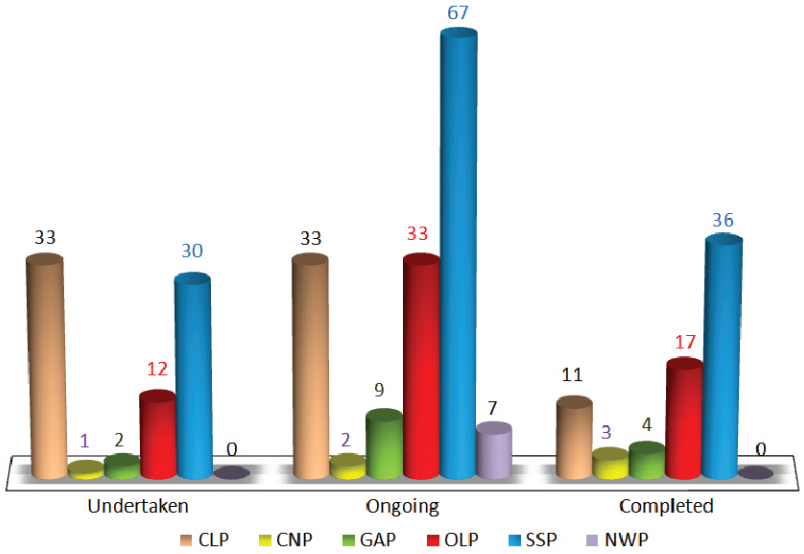
*As on January, 2015

ECF & Their Projectwise Distribution during July-December, 2014

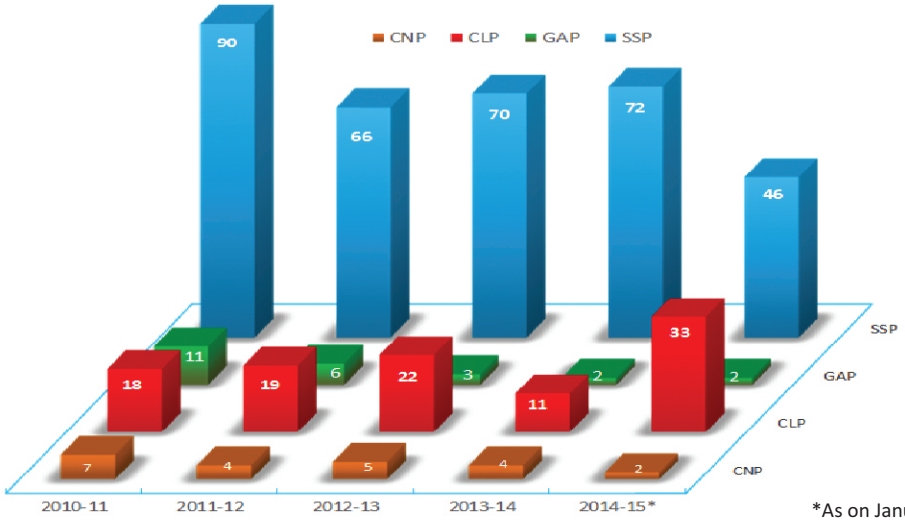


ECF from Govt., Industry and Foreign Organization

Our project portfolio continues to be dominated by industry sponsored projects. Tata Steel continues to be one of our largest sponsorer and this year we have taken close to 40 collaborative projects with them. The plots below gives the present status with respect to various category of projects undertaken , ongoing and completed this year in comparison to those over the past five years :

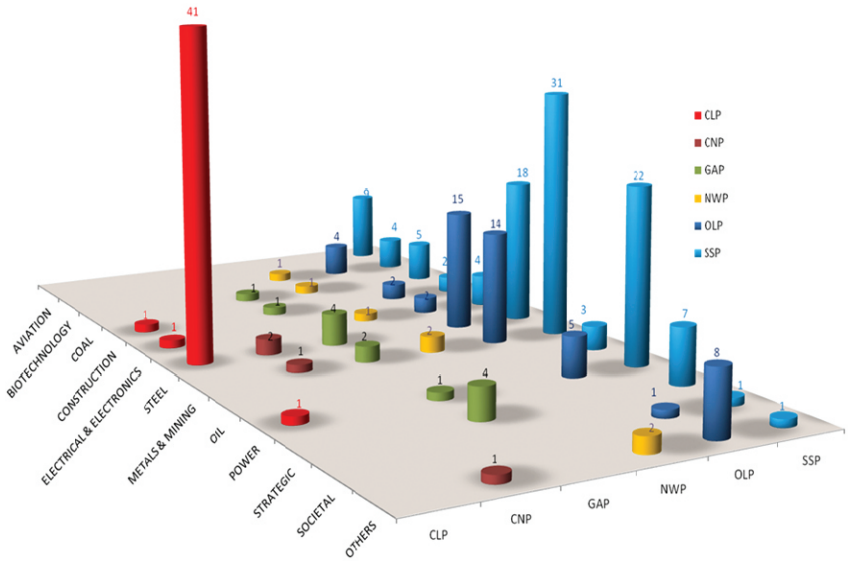


Project undertaken (ongoing and completed)



*As on January 2015

Project undertaken under various categories during 2010-15.

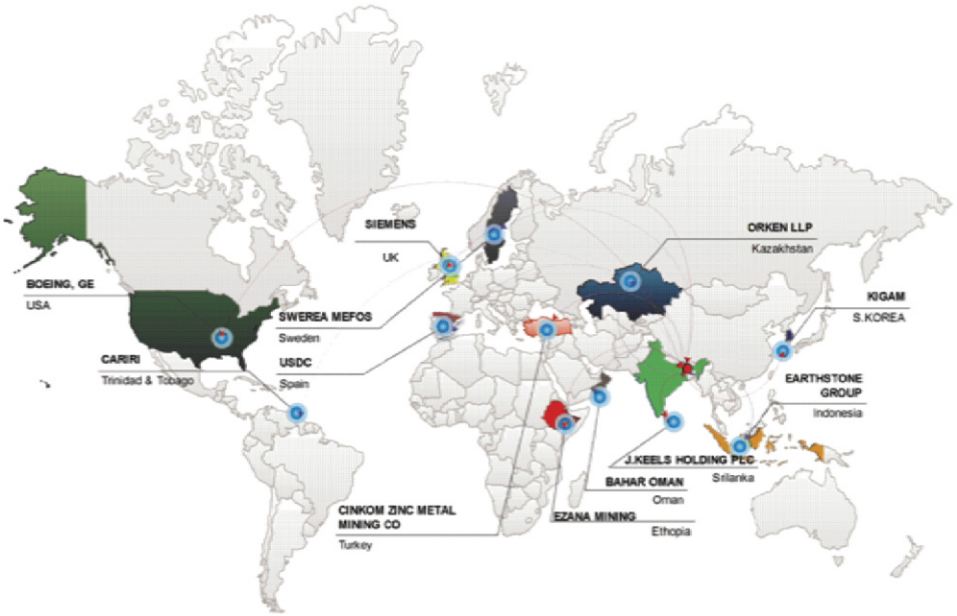


Ongoing various projects in Industry Sectors

Some of the exciting projects taken up are :

- Development of NDE tools for quantitative estimation of creep damage in P22 and P91 steels for NTPC, Ltd.
- Development of a process for the electrolytic extraction of Gd for IGCAR, Kalpakkam
- Optimization of continuous annealing parameters of a variety of new grades of steels (IFHS, DP etc.) for Tata Steel using the Annealing Simulator
- Development of a process for the complete recycling of LD slag; recovery of P as P_2O_5, Fe as pig iron and CaO rich slag as coolant in BOF or as sinter feed
- Development of online temperature monitoring system for the mould in billet caster using FBG sensors
- Design and development of ultrasonic flow meter for ISRO
- Assessment of residual stresses in shot peened 4340M steel subjected to fatigue damage using Magnetic Barkhaussen Emission technique
- Development of Non-linear Ultrasonic technique for multi-axial fatigue damage evaluation

The Research Projects secured from International Clients last year has also remained good as shown below :



International Collaborations through Contact Research.

SIGNIFICANT ACHIEVEMENT IN PROJECTS DURING JULY-DEC 2014

A brief on each of the ongoing projects including the objective, time duration, deliverables and the progress made in the past six months is compiled in the RC agenda document provided. I have highlighted below the significant achievements from these projects in the past six months:

- Successful commissioning of a 1.3 mTPY iron ore beneficiation plant at M/s. Usha Martin Ltd. based on the flow sheet developed at CSIR-NML.
- Trials on de-phosporisation of DRI successfully carried out in a 6 ton induction furnace at M/s. AC Steel, Raipur, Chattisgarh using the flux developed at CSIR-NML. The P-levels was reduced from 0.085% to 0.06%.
- Process for production of DRI utilizing iron ore slime and Jhama coal in tunnel kiln tested successfully at tonnage scale at M/s. Mayur Electroceramics and is likely to be commercialized by them soon.
- 60 tonnes of iron ore slime briquettes successfully tested as coolant at the LD converters in Tata Steel.
- Successfully developed a process at pilot scale for the recovery of potash from feldspar with simultaneous recovery of ferrosilicon and nano-crystalline/amorphous silica.
- IR thermography system for compositional analysis of iron ore commissioned at the Noamundi mines of Tata Steel.
- GMI based device developed for health monitoring of carburized structures in the petrochemical industries.
- Developed and field tested (at M/s. ISWP Jamshedpur) an Eddy Current based device (Flawguard) for detection of transverse cracks in steel wires. This device will be implemented at M/s. Tarapore Wire Mill next month.
- Maceral and functional group identification on a variety of coking and non-coking coals to understand the maceral and structural characteristics responsible for the coking behavior.

Patents Filed

In the last six months 12 patent applications have been filed, of which six applications are jointly with Tata Steel Ltd. The patents filed are : (i) *Iron cobalt Based High Induction soft magnetic amorphous alloys;* (ii) *A novel processing scheme for multi stage multi product dry beneficiation of coal using air fluidization on an inclined deck;* (iii) *An improved method to produce cold bonded briquettes from iron ore;* (iv) *A process for production of directly reduced iron in tunnel kiln;* (v) *A process for production of directly reduced iron (DRI) in tunnel kiln;* (vi) *A process for the electro-thermic production of magnesium metal;* (vii) *An improved process for the reduction of chromite ore;* (viii) *An improved giant magneto impedence sensor device for structural integrity assessment of engineering components;* (ix) *An improved process for preparation of iron oxide pellets using sodium lingo-sulphonate containing wastes and copper smelting slag replacing bentonite;* (x) *Auxiliary cold chamber for an improved annealing simulator device;* (xi) *Corrosion resistive graphene oxide based coating of metals using seedlac and vegetable oil,* and (xii) *Cu-based ductile bulk metallic glass and a process for the preparation of the same.*

MoUs/Agreements Signed

Since the last Research Council meeting, a large number of MoUs were signed with various clients including several international organizations. These are : 1) *General Agreement for R & D in Iron & Steel- M/s. Steel Authority Of India Limited, Ranchi;* 2) *Study on the interface layer formation during hot dip Galvanizing/Galvannealing of advanced high strength steels for automotive applications (development of technology for hot dip galvanizing of AHS Steel for automotive application) - M/s.Tata Steel Limited, Jamshedpur;* 3) *Dephosphorization of steel made through induction melting - M/s. NISST , AIIFA, Gobindgarh, Punjab;* 4) *Annealing Simulator -M/s.Tata steel and M/s. Krisjan India Jamshedpur;* 5) *Development of a knowhow for the production of porous sintered biphasic blocks with pore size of 300-500 microns - M/s. G. Surgiwear Ltd., Shahjahanpur;* 6) *Confidentiality agreement-M/s. Shree Mahabir Refractories*

works, Ranchi; 7) *Alternative Degassing Process for molten copper/alloy- M/s. Rapsri Engineering Products Co. Ltd;* 8) *Collaborative activities on melting direct reduced iron (DRI) using gas based furnace - M/s. Mayur Electro Ceramics Pvt. Ltd. Kolkata;* 9) *Services for the technical modifications and upgrading of annealing simulator- M/s. Krisjan India, Jamshedpur;* 10) *Know- how for preparation of DRI in tunnel kiln using Jhama Coal and slimes - M/s. Tata Steel Ltd.& M/s. Mayur Electrocerami, Kolkata;* 11) *Development & fabrication of prototype pulser for ultrasonic flow meter-M/s. Electronics & Engineering Co. Ltd., Mumbai;* 12) *Production of ferrite and pigment grade mono-dispersed nano iron oxide- M/s.Tata Pigments Ltd., Jamshedpur;* 13) *Development of Magnesium Metal Production Technology (MPT)-M/s.IIT Kharagpur;* 14) *Effect of inclusions on pitting corrosion on line pipe steel- M/s ONGC, Mumbai;* 15) *Confidential agreement- gasifier project at Jamnagar and its byproduct slag-M/s. Reliance Industries Limited, Mumbai;* 16) *High strain rate deformation behavior of polymer and steel-Renault M/s. Nissan Technology Pvt. Ltd., Kanchipuram;* 17) *Anti-tarnishing Lacquer - M/s. Multicoat Surfaces Private Limited, Jamshedpur;* 18) *Feasibility studies on the development of gadolinium metal by fused salt electrolysis of gadolinium chloride- M/s. IGCAR* and 19) *Agreement between CSIR-NML & Tata Steel Ltd for Patent Analytics -M/s. Tata steel Limited, Jamshedpur.*

Awards / Distinctions/ Fellowships Received

- Most Significant CSIR Technology of the Five Year Plan Period- "Development and commercialization of column flotation technology for the beneficiation of low-grade mineral deposits"
- Skoch Awards for 2014-"Inquest- An e-reporting system"
- Dr. Indranil Chattoraj, Chief Scientist received NIGIS Corrosion Awareness Award 2014 conferred by NACE International Gateway India Section
- Dr. Ashis Kumar Panda, Sr. Scientist won the National NDE award for System Innovation and Development The award was given by Indian Society for Non-destructive Testing (ISNT) at their annual seminar held at Pune during December 4-6, 2014
- Dr Bibhuranjan Nayak, Principal Scientist, won the H.S. Pareek Award of the Geological Society of India for the year 2014.
- Dr. Abhilash, Scientist received Young Scientist Award 2014 of the Biotech Research Society, India for the year 2013.
- P. Ramachandra Rao- Best Employee Award 2013-14 -(1) Shri Anjani Kumar Pandey, S.O. (Non-Technical Category) and (1) Shri B.M. Srinivasa Rao, and (2) Shri A.K. Upadhyay, BDM Division (Technical Category).
- Dr. (Ms.) Subhadra Garai, Scientist and Dr. Arvind Sinha, Sr. Principal Scientist received Dr. B.R. Nijhawan Award for the Best Technical Paper for the paper, entitled Biomimetic nanocomposites of carboxymethyl cellulose-hyroxyapatite: Novel three dimensional load bearing bone grafts, Published in Colloids and Surfaces B: Biointerfaces, 115 (2014), pp. 182-190.
- Mr. Ranjeet Kumar Singh, Dr. R.K. Rath, Ms. Sunati Mohanty, Dr. Mamta Sharma and Dr. Ratnakar Singh received Prof. VA Altekar Award for the Best Technology for the technology, entitled Development of process technology for beneficiation of dumped low grade iron ore fines for iron and steel making.
- Dr. A.K. Mohanty , Dr. S. Chakraborty, Dr. S.K. Tiwari, Dr. T. Mishra, and Dr. J.K. Sircar received Prof. Shilowbhadra Banerjee Award for Best In-house Project for the project, entitled Development of novel corrosion inhibitors for copper and its alloys.

In addition, several scientists and technical officers received awards for best presentations in various conferences.

Distinguished Visitors

- Dr. Thomas Poinot, Post Doctoral Associate at MIT Tata Centre delivered a lecture on "Activities of Tata Centre at Massachusetts Institute of Technology, A Glimpse" on 08/12/2014
- Mr.Michael Laracy EIT, Master Candidate-Tata Fellow Civil and Environmental Egineering, MIT Tata Centre delivered a lecture on""Use of Boiler ash for geopolymer brick" on 12-09-2014
- Ms Snigdha Ghosh, Target Corporation of India, Bangalore delivered lecture on "Modelling of LD converter" at CSIR-NML. on 10-10-2014
- Prof. H S Ray, Adjunct Professor, B E College, Shibpur, Howrah delivered "Dreams & Connectivity" at CSIR-NML" on 28-10-2014
- Dr K N Udupa, Head Chemistry, Scientific Services, Tata Steel, Jamshedpur delivered a lecture on "Uncertainty Measurement: ILCT & PT - Importance in NABL".
- Dr.Somnath Bhattacharyya, TIFR Mumbai delivered a talk on "Spectroscopy without spectrometer; using different modes of TEM images to determine chemical composition" on 28-11-2014
- Mr. Vrettos Stelliou, Area Manager, Nanomegas delivered a lecture on "Precession Electron Diffraction Applications in TEM : from crystal structure determination to orientation imaging and strain mapping at nm " on 12-11-2014

Foreign Depution

- Dr. S. Prabhakar, Chief Scientist, NML- Madras Centre was deputed to USA to attend "ASISC Annual Meeting". during 08/08/2014 to 08/24/2014.
- Dr. Amitava Mitra, Chief Scientist was deputed to Spain under the prestigious fellowship "Mobility grants for guest researchers at Campus Iberus" within the campus of International Excellence Programme promoted by Spanish Ministry of Education at Public University of Navarra, Pamplona, Spain during 09/01/2014 to 11/30/2014.
- Dr. Abhilash, Scientist was deputed to China to attend 6th international conference on hydrometallurgy during 10/16/2014 to 10/19/2014.
- Ms. Pratima Meshram, Scientist was deputed to China to attend 6th international conference on hydrometallurgy during 19-10-2014 to 14-06-2020.
- Dr. L. Sharmistha Sagar was deputed to South Korea to participate in the workshop on Current and future trend of non linear ultrasonic techniques for NDE during 21-10-2014 to 24-10-2014.
- Dr. Ashok Kumar Ray was deputed to USA to attend the 2nd World Congress on Petrochemistry and Chemical Engineering during 27-10-2014 to 29-10-2014.

Human Resources

Fourteen employees superannuated over the past six months: Dr.Vinay Kumar Chief Sct., Shri Amrit kumar Shaw, Lab Asst., Shri. Jharkhandey Singh, Lab Astt., Dr. Swatantra Prakash, Chief Sct., shri. Biswanath Shaw, Security Guard, Dr. Ram Parvesh Bhagat, Chief Sct., Dr. Narayan Parida, Chief Sct., Shri. N.Venkateshwar Rao, Lab Asstt., Shri Surendar Nath Dhar, Lab Astt., Shri. P.Chandra Shekhar Dev, Lab Attd(2), Shri. Malay Kumar Das Biswas, Astt.(S&P) Gr.I, Shri Janardan Sharma, S.Guard, Shri. P.N.Swamy, Sr. Steno and Shri Arunava Bagchi , S.O.(F&A).

We wish all of them a happy and healthy life after superannuation.

Major Events

- Visit of Ethiopian Delegates- A high power delegation comprising of Ethiopian Minister of State for Industries His Excellency T.H. Tessema along with W.D. Shumete, Director

General of their Metal Industry Development Institute and three of the directors D.A. Woldemichael, M.D. Asires, and E.A. Mihretu of the same institute visited CSIR-NML.

- ISO Certification Audit during 5 - 7 Aug 2014- Mr Prosenjit Mitra, Auditor TUV-SUD South Asia Pvt. Ltd and his team audited CSIR-NML.
- Workshop on Women Empowerment in Science and Technology (WEST-2014) was organised during 24-25 September 2014 under the aegis of National Academy of Sciences, India (NASI). 140 Women Researchers / Lecturers across Jharkhand State participated in the Workshop.
- INAE School on Characterisation and conservation of archaeological objects conducted during 13-17 October, 2014. 42 participants from all over the country attended.
- 72nd CSIR Foundation Day Celebrations - The chief guest of the function was Dr. Krishnaswamy Kasturirangan, President, National Academy of Sciences (NASI) and former member of Indian Planning Commission. Dr. Kasturirangan delivered the foundation day lecture on the overview of future space programs and prospects of Indian Space Mission. More than 200 school children from the schools in and around Jamshedpur also attended the program. An essay competition was also organized within the laboratory on this occasion.
- 65th CSIR-NML Foundation Day Celebration (26th Nov 2014)- Dr. R. Krishnan, Formerly Director, Gas Turbine Research Estt., Bengaluru & Naval Chemical and Metallurgical Laboratory, Mumbai; Chief Controller R&D, DRDO, New Delhi graced the occasion as the chief guest. He delivered the first Dr. Nijhawan Memorial Lecture and presented awards of different categories to CSIR-NML staff and meritorious children of staff.
- 5th Prof. P. Ramachandra Rao Memorial Inter School Quiz (24th Nov 2014)- Quiz Master: Mr. V. V. Ramanan. Kerala Samajam Model School, Jamshedpur became the winner and Loyola School, Jamshedpur became the runners up in the quiz.

AcSIR Activities

During the period from July - December 2014, the first batch of Integrated M.Tech-PhD (IMP) students admitted in August 2012, have completed their M. Tech course and all the five IMP students have been awarded degree during the fouth convocation of AcSIR on August 28, 2014. Integrated M. Tech-Ph. D students admitted in August 2013 session have also completed their course work in June 2014 and in the last one semester (July - December 2014)have been working on their dissertations. In August 2014, AcSIR-NML admitted eight IMP students and ten PhD students which include three industry sponsored students and five post M.Tech students. Mr. Ganesh Chalavadi, SRF, has submitted his PhD thesis (first Ph D thesis of AcSIR-NML) in November 1st week while two more students have successfully defended their comprehensive viva-voce examination.

Institutional Repository

The NML Institutional repository (http://eprints.nmlindia.org) continued to maintain its predominant position in the country (ranked 13th in http://repositories.webometrics.info/en/Asia/India) in terms of global visibility and popularity with average hits of over 0.24 million per month and a cumulative total of over 11.54 million hits since inception (2009). The researchers from 196 countries have accessed NML repository. During last two months 142 countries (highest users in a month) have accessed the database.

13 February, 2015

(S. Srikanth)
DIRECTOR